IMPACT MELT-BEARING DEPOSITS AROUND MARTIAN CRATERS. W. A. Yingling[1,2], C. D. Neish[1,2], L. L. Tornabene[1,2], [1]Institute for Earth and Space Exploration, The University of Western Ontario, London, ON, Canada, [2]Department of Earth Sciences, The University of Western Ontario, London, ON, Canada (wyingling@uwo.ca).

Introduction: Impact cratering is a dominant process which shapes the surface of planetary bodies. Impact melt is created during the excavation and modification stage of crater formation, where host rock is melted due to the imparted energy [1]. Impact melt deposits have been studied on the Moon, Venus, Mercury, Mars, and Ceres [1-8]. However, work has yet to be done to determine what controls the distribution of impact melt deposits on Mars. This is the aim of our study.

Understanding the dominant mechanisms controlling impact melt distribution on distinct bodies can help us gain insight to the impact cratering process. Melt production and their final distribution can be influenced by impact velocity, gravity, impact angle, surface composition, topography, and/or the presence of an atmosphere [1,2]. This research focuses on mapping impact melt exterior to the most well-preserved Martian craters. We wish to determine whether impactor angle or local topography dominates the emplacement process on Mars, and how this relates to the gravity and impactor speeds of different terrestrial planets.

To achieve this for Mars, first we look to past work. Neish et al. [4] showed that the Moon and Venus represent two different end members in terms of impact melt emplacement on terrestrial planets. Venus has a higher relative gravity and impactor speed, and impact melt emplacement is influenced primarily by impactor angle. The Moon has a relatively low gravity and impactor speed, and impact melt emplacement is influenced by local topography. In addition, work by [8] has tentatively shown that melt emplacement on Mercury tends more Venus-like than Moon-like. Mercury has a lower gravity than Venus, but higher impact speeds, implying impactor speed may be a more important factor in melt emplacement than gravity.

To test this hypothesis, we look to Mars, which has the same surface gravity as Mercury, but lower impactor velocities than the Moon [9]. We aim to assess whether the primary influence on melt emplacement on Mars is impactor angle dominated or topographically dominated. We hope to use this information to infer the relative importance of gravity and impactor velocity in impact melt emplacement on terrestrial planets. In this work, we will assess the most well-preserved craters because Mars maintains an atmosphere that contributes to resurfacing processes that could obscure the identification of melts.

Objectives: The overall objectives of this work are to (1) find a statistically significant number of Martian craters where melt bearing materials are present and discernable, based on the well-preserved crater database from [6], (2) identify and map where melt bearing deposits are emplaced in relation to their craters, and (3) use a statistical test to assess the correlation between local topography and emplacement direction.

Methodology: A database compiled by [6] was used as a starting point for identifying well-preserved craters exhibiting melt-bearing material on Mars. We use well-preserved craters because on Mars melt-bearing material can become obscured after the crater formation due to degradational processes. By using the most well-preserved craters we will be able to assess the best candidates for our morphological analysis. Each crater from within the database by [6] is re-evaluated with respect to their ejecta deposits based on our "melt" confidence classification. A good candidate will have a combination of the following melt features: clear signs of ponded melt deposits, signs of flow in/around crater, cooling cracks, flow dissection, tonal or composition distinction from surrounding material, pitted material, impact melt veneer, and few signs of aeolian processes. Analysis of the melt bearing material exterior to crater rims is conducted primarily through GIS. Once a site has been satisfactorily mapped, it is given a designation of confidence, indicating our trust in the existence of the melt bearing materials there. Craters that exhibit three or more of the attributes mentioned above are given a confidence value of "high". Craters with two attributes are given a designation of "medium". Craters with one of the attributes are given a designation of "poor".

Ideal candidates will also have good CTX or HiRISE DEM coverage, which will enable elevation profiles to be taken where melt bearing materials are thought to exist. Ponding is theorized to occur in topographic lows and their surfaces should behave as equipotential surfaces in elevation data [6]. An example of the mapping process for an ideal candidate is shown in Fig. 1.

The location of the melt-bearing materials will then be assessed with respect to their relative location to the crater rim crest low (see Figure 2), also referred to as "RCL". Correlation between the two features will be analyzed using an Anderson-Darling statistical analysis. The results will then be compared to emplacement trends that have been studied on other terrestrial bodies, including Venus, the Moon and Mercury [3-5,8].

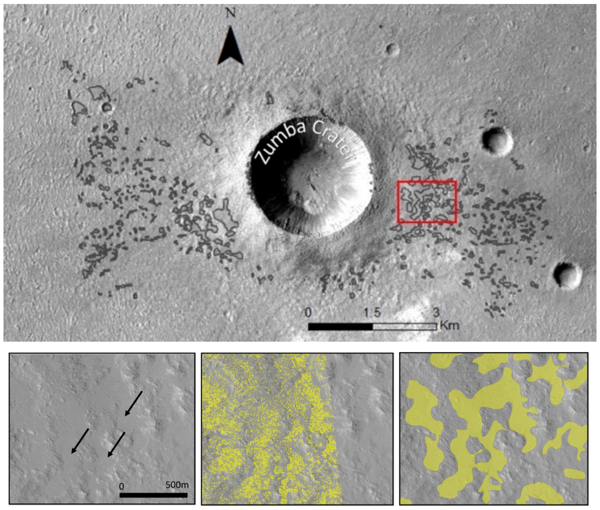

Figure 1. (Top) CTX B12_014262_1513_XN_28S133W Image of Zumba Crater. Gray outlines show mapped melt. (Left) HiRISE Image: PSP_003608_1510 image of red box from top image. Identification of melt pools requires visual verification. Arrows point to areas of supposed melt. (Bottom Center) Slope derived data from HiRISE PSP_002118_1510 and PSP_003608_1510 stereo-images are used to further confirm the presence of melt ponds. Yellow indicates slopes of less than 3 degrees. (Right) Based on the synthesis of both morphology and derived slope, melt pools are mapped in yellow.

Candidate Name	Latitude	Longitude	Melt Direction	RCL	DTM
AcheronFossae	40.52	-128.347	S	S	HiRISE
Noord	-19.22	-11.179	W	NE	CTX
Tooting	23.184	-152.214	N	NW	CTX
TyrrhenaTerra	-18.613	69.045	W	W	CTX
Zumba	-28.658	-132.968	W, E	S	HiRISE

Table 1. Table showing preliminary results for a handful of high confidence candidate sites. Note our results for Zumba Crater agree with [6].

Results/Discussion: At present, a total of 29 candidate sites have been mapped. Nine craters fall under high confidence, eight craters under medium confidence, and twelve under poor confidence. Work to be done includes finding more candidate sites that fall under the "high" confidence category.

Table 1 shows preliminary results for five high confidence candidate sites. For Zumba Crater (Fig 1), we see a melt distribution to the east and west of the crater but a rim crest low to the south, possibly indicating an impactor angle dependent mechanism for this crater [6]. If Zumba's emplacement mechanism was topographically dependent, we might see a higher concentration of melt to the south. On the contrary, there is very little melt deposits south or north of Zumba. This work agrees with [6], where Zumba's emplacement is suggested to be most influences by impactor angle. In contrast, three other high confidence craters have dominant melt directions with 45° of the RCL, suggesting topography also plays a role in impact melt emplacement on Mars. Additional work is needed to determine the most common emplacement style.

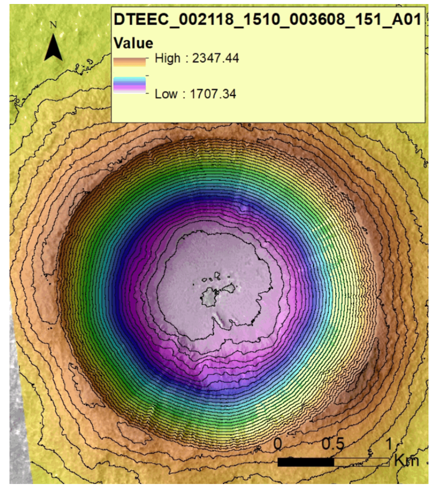

Figure 2. HiRISE DTM of Zumba Crater from HiRISE PSP_002118_1510 and PSP_003608_1510 stereo-images. Overlain on CTX image B12_014262_1513_XN_28S133W. White represents topographical lows and dark red represents highs. The black lines represent contours at 20 m intervals.

Conclusions: Mars is a connecting bridge, in terms of the emplacement of melt-bearing materials, between terrestrial planets because of its gravity regime and impactor velocity. This study will elucidate the possible dominating emplacement mechanisms for Martian conditions by looking at the most well-preserved craters. This result will then be compared and contrasted to other terrestrial bodies, including Venus, the Moon and Mercury.

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